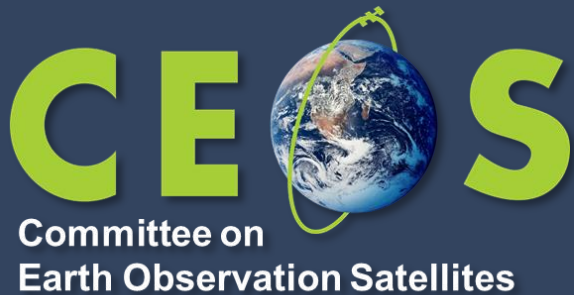


CEOS Strategy to Support the UNFCCC Global Stocktake

Carbon from Space 4

ESRIN

25-28 October 2022



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ESA CEOS Team

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& University of Cambridge, Chemistry Department**

Relation of GST to the Paris Agreement



The Global Stocktake (GST) is a fundamental part of the Paris Agreement and provides ongoing estimates of progress towards its objectives. It is described in the Paris Agreement itself (Article 14, quoted below):

....”Parties shall take stock of the implementation of the Paris Agreement to assess collective progress towards achieving the purpose of this Agreement and its long-term goals (referred to as the “global stocktake”)...”

“... in a comprehensive manner....considering **mitigation, adaptation and means of implementation and support, and in the light of equity** and the best available science”

...in 2023 and every five years thereafter....”

“...shall inform Parties in updating and enhancing, in a nationally determined manner, actions and support in accordance with the relevant provisions of this Agreement.....”

- ❖ This supports work to relate satellite observations of atmospheric GHG composition to surface GHG emission
 - Inversion process must **account for all emissions, natural and anthropogenic**, including biogenic emissions and removals
 - Natural carbon flux models are to a large extent driven by satellite observations of the surface model parameters (land and ocean). Space agencies should **check with partners, particularly the modelling community, for completeness of observations requirements**.
 - We cannot rely solely only on the **ECVs defined by GCOS** as in the past for the requirements for satellite programmes as GCOS has only relatively recently considered the issues of rate parameters and fluxes.
 - These considerations lead to **augmentation of the ongoing work of the CEOS GHG Task Team**, as in the recommendations
- ❖ It could be of value to consider **two or three IMBIE-class experiments** to provide consolidated datasets over specific areas to consolidate local models. Areas such as the Amazon basin, Siberian tundra are good examples of where such work might be of value..

- ❖ **Recommendation 1:** WGClimate GHG Task Team should consult with the relevant elements of CEOS, including Associates such as ISC, WCRP and GCOS, together with modellers, to check the GHG Implementation roadmap on completeness concerning requirements for terrestrial observation (SIF; NPP, land cover, biomass, etc.) for supporting mitigation actions through the development of Monitoring and Verification Systems (MVS).

Status: Ongoing. GHG Task Force has already augmented its membership to help address this recommendation. It has implemented this in part already and was further addressed at JRC Workshop in Nov 2021 and at CEOS Working Group Climate Workshop in Feb & Oct 2022.

- ❖ **Recommendation 2:** The need for parallel inputs to ocean models deemed necessary for the support of MVS and for a wider validation of carbon flux estimates globally should be considered and appropriately combined into the actions in Annex C of the GHG roadmap. This should also be led by the WGClimate GHG TT in cooperation with CEOS Ocean specialist groups and modelling groups, together with GCOS, GOOS, WCRP and individual agencies.

Status: due to be implemented after Recommendation 1 above, as second priority.

- ❖ **Recommendation 3:** *The results of the actions from the above recommendations should inform (a) the report of CEOS to UNFCCC/RSO discussion on observations to support the implementation of the Paris Agreement and should pro-actively flow into (b) the consultancy process of the UNFCCC / Ad hoc group for the Synthesis Report on Systematic Observations.. CEOS and its Agencies should argue to be a primary source of consistent global land and ocean surface data (land cover type, biomass, phenology...) in the discussion with UNFCCC/RSO, in addition to providing the integrated measurements of GHG and co-emitted species in the atmosphere.*

Status: Active participation by various CEOS Groups (WG Climate, GHG TF, AFOLU TF) in report to SBSTA at CoP26, including elements from Recommendation 1. To be pursued also at COP27 and subsequent COPs.

- ❖ **Recommendation 4:** *CEOS should consider, in conjunction with modellers, setting up one or more focused observational campaigns in the areas suggested above (Amazon Basin, Northern tundra), or others, as a major contribution to the understanding of the trends of natural GHG emissions and removals in key areas. (IMBIE may be seen as a possible model.)*

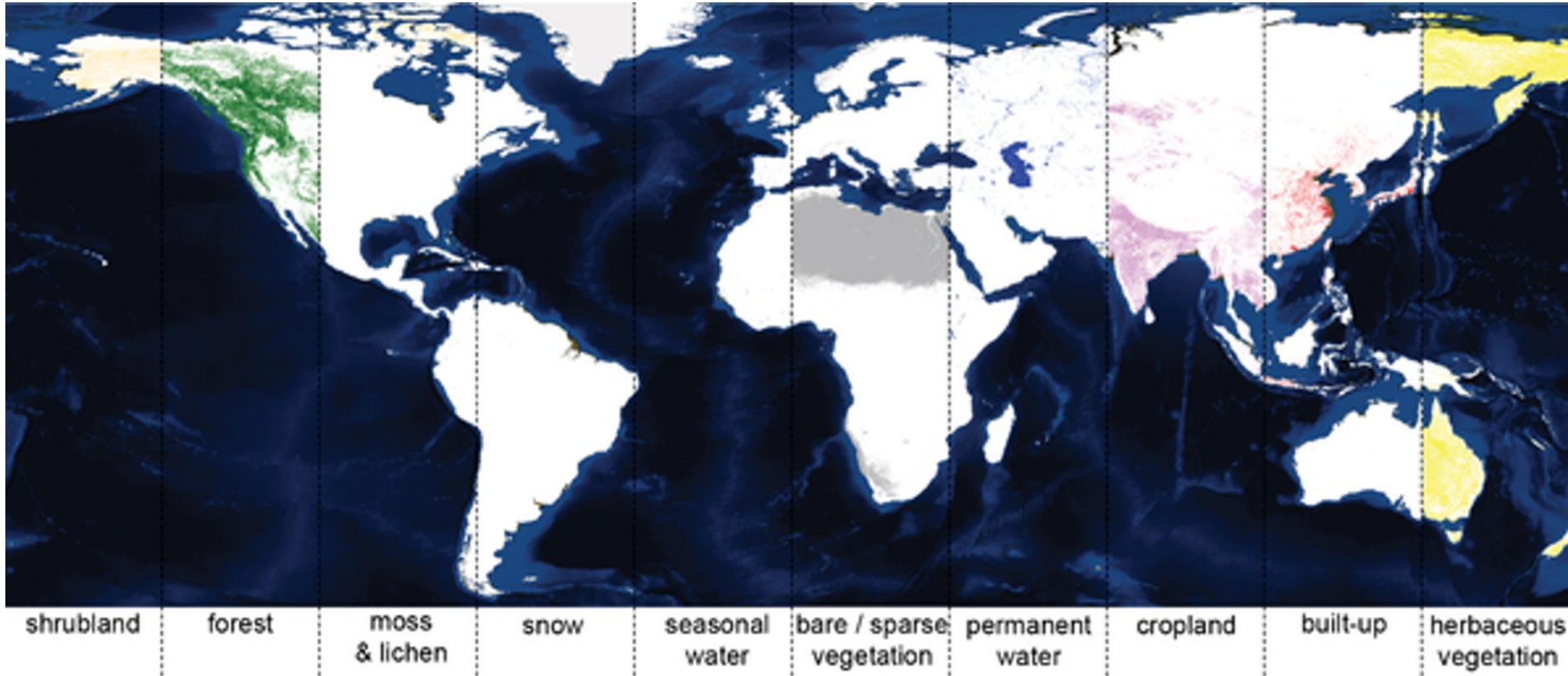
Status: ongoing. CEOS (incoming SIT Chair) to continue discussion with community on current active plans and report to SIT 2022.



CEOS has launched a brand new Global Stocktake Portal to help countries locate, understand, and apply the rich datasets available from the world's space agencies. GST Portal resources provide a single point of access to all the datasets and guidance resulting from CEOS GST activities, as a convenient reference for Parties, and for scientific and other users to access, understand, and apply the data. Descriptions are provided for each dataset, along with links to the data itself, available user manuals or guidance documentation, and point of contact information for each case. We invite you to explore the [CEOS Global Stocktake Data Portal](#), available in English, French, and Spanish for further details and access to the datasets of interest, including some world-first prototype inventory products for carbon dioxide and methane.

Note that the portal represents the culmination of substantial work by dozens of teams and individuals across the CEOS community, especially our CEOS Greenhouse Gas and AFOLU Roadmap teams, who worked intensively to ready their respective datasets to feature in the portal.

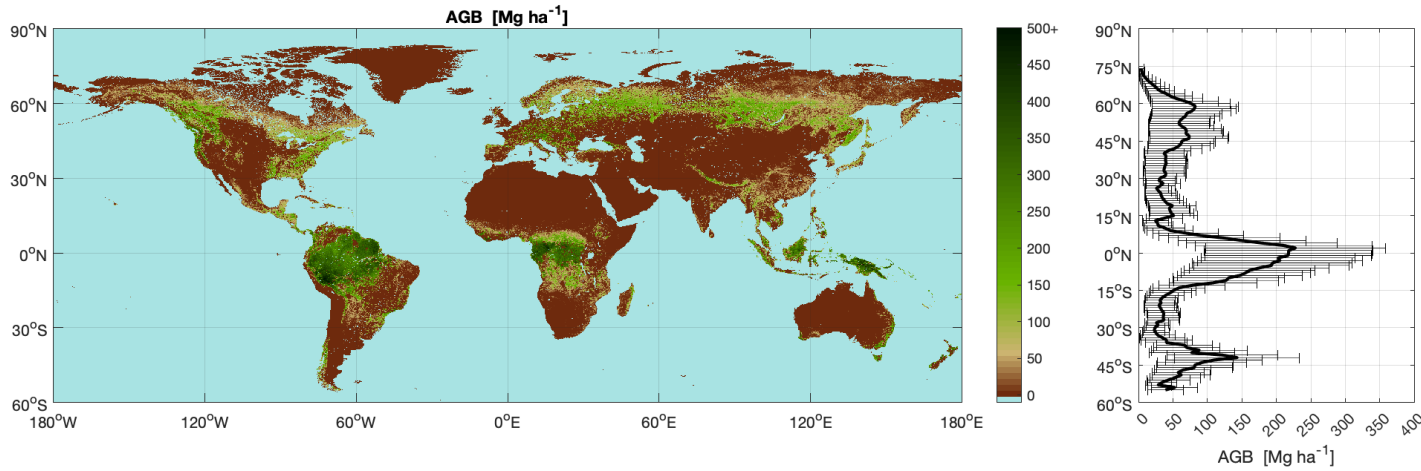
Annual land cover



Copernicus CLMS Product (Buchhorn et al (2020) DOI [10.3390/rs12061044](https://doi.org/10.3390/rs12061044))

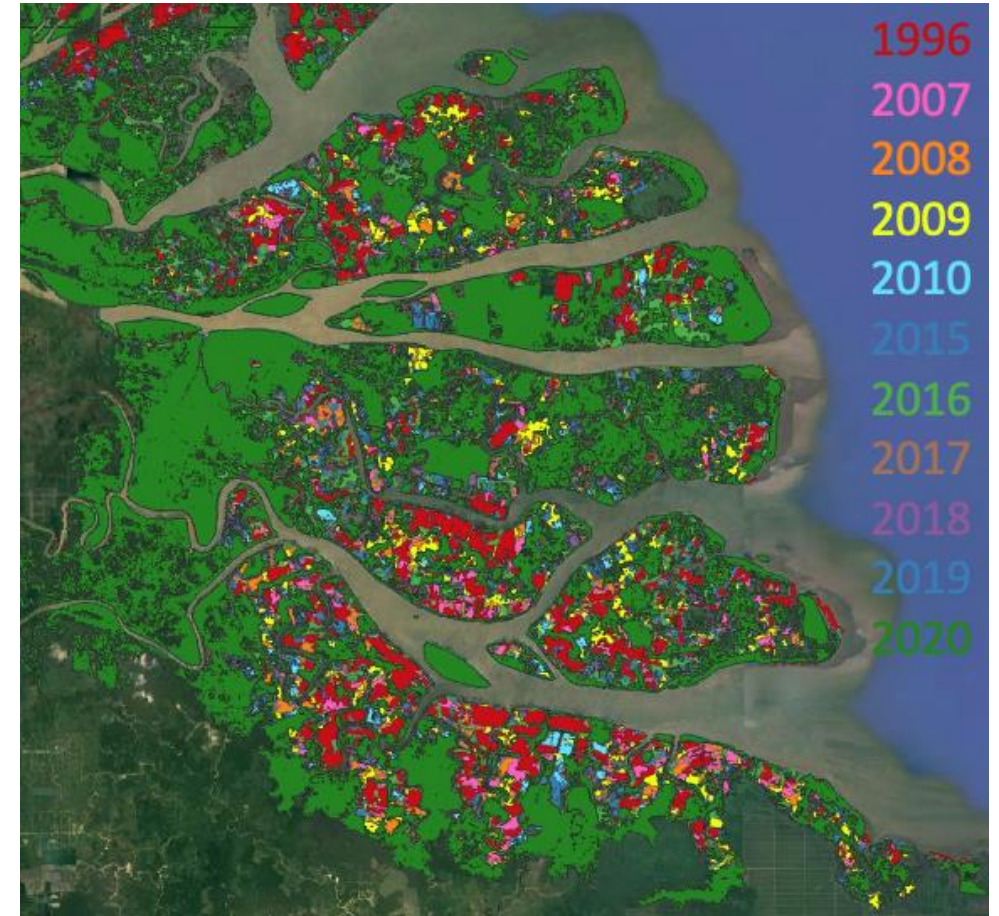
Also available : World Cover 2020, CCL Land Cover, HILDA+,

Rec 3: eg Biomass, Mangrove distribution products

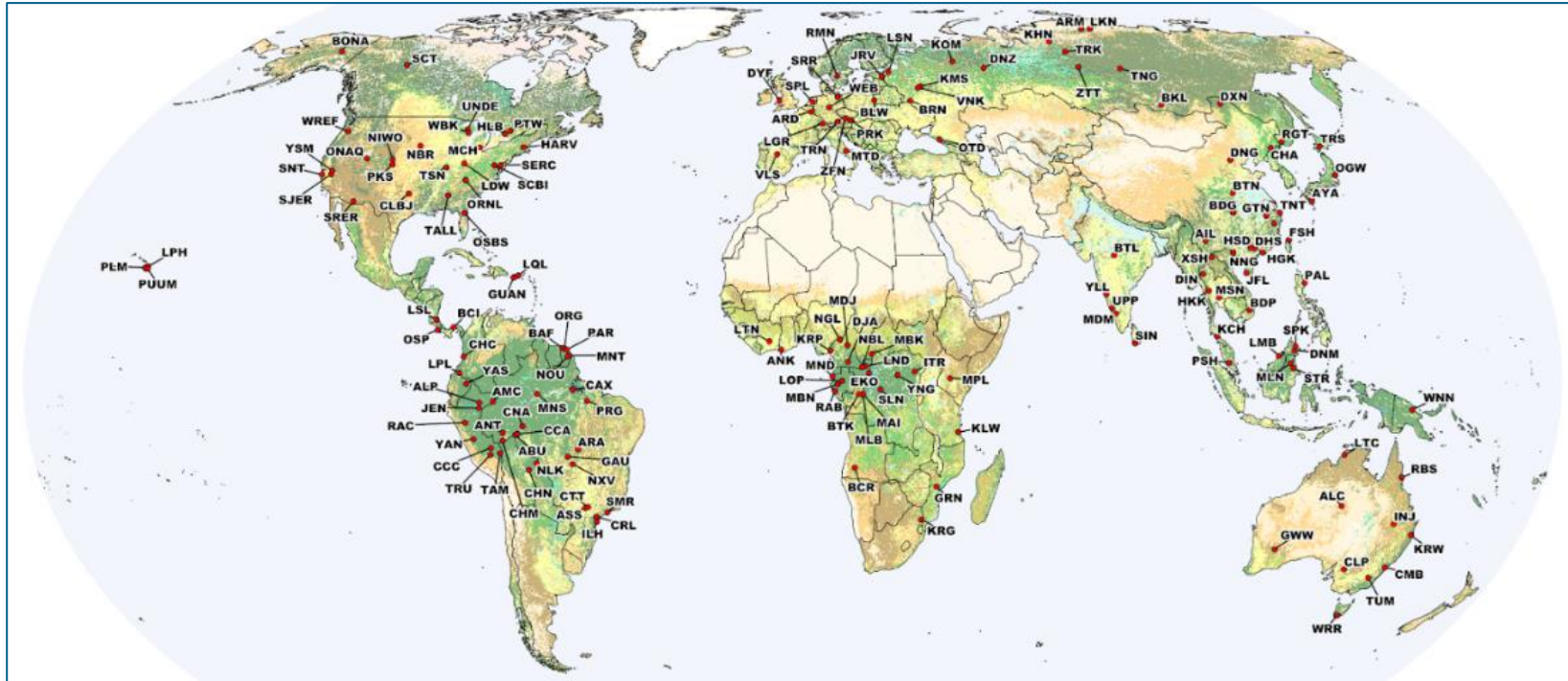


ESA CCI AGB product,
100m x 100m resolution, {2010, 2017, 2018, 2020...}

Global Mangrove Watch
Platform: www.globalmangrovetwatch.org



Global Forest Biomass Reference System



... and others



J. Chave et al., Biomass Validation Strategy Document

- ❖ NASA/ESA conducted AMPAC Campaign aimed at understanding methane emissions from tundra under warming conditions. Included airborne, satellite (TROPOMI) and model data.
- ❖ Discussions on possible campaigns with both public sector and private sector in oil and gas extraction locations eg Permian Basin, including discussion with IMEO partners (UNEP, Environmental Defense Fund, GHGSat etc.)
- ❖ Further possibilities for such campaigns in eg Amazon Basin exist and can be considered with science community through e.g. Carbon from Space 4 Workshop, WMO GHG Workshop

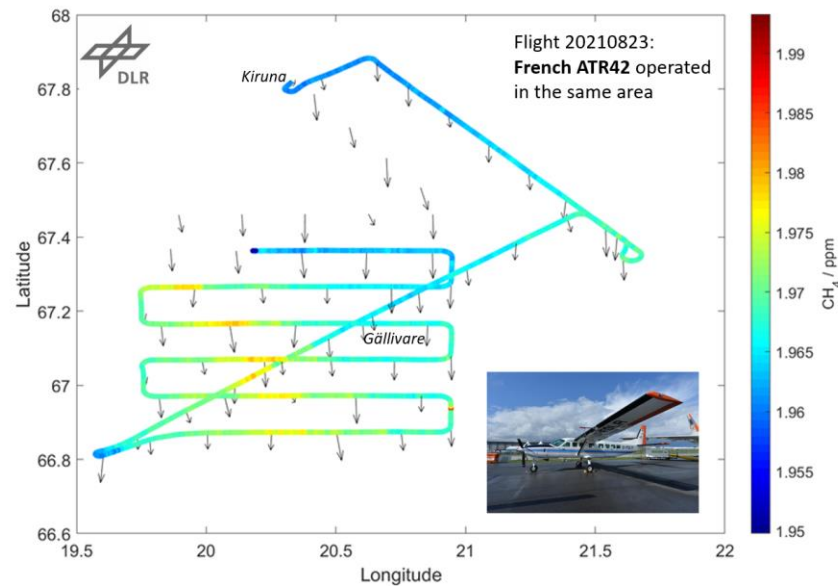
MAGIC4AMPAC: Arctic Methane sensing campaign 2021

First MAGIC4AMPAC results:

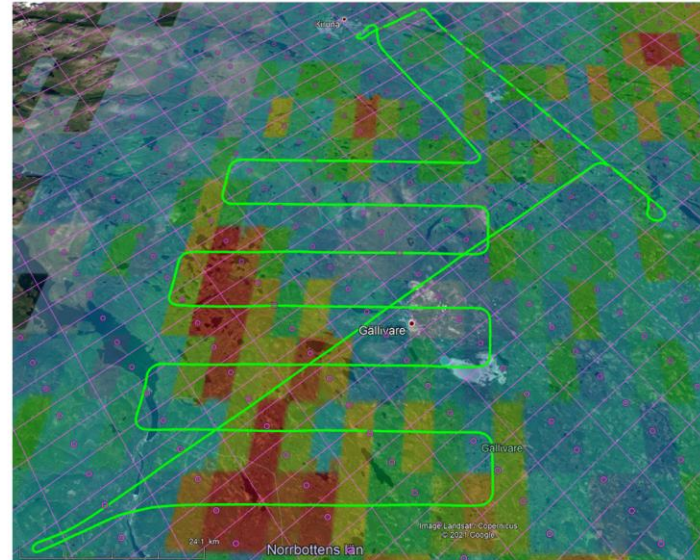
- Successful airborne measurements of CH₄ from Arctic wetlands in Scandinavia
- First intercomparisons with the Finnish JSBACH CH₄-emission inventory are promising
- Methane validation flights with TROPOMI were planned and successfully performed

Example: 20210823

DLR-Cessna in situ CH₄ measurements (PICARRO instrument)



Preliminary data! Please contact anke.roiger@dlr.de or Heidi.Hunrieser@dlr.de



JSBACH-HIMMELI CH₄ emission inventory

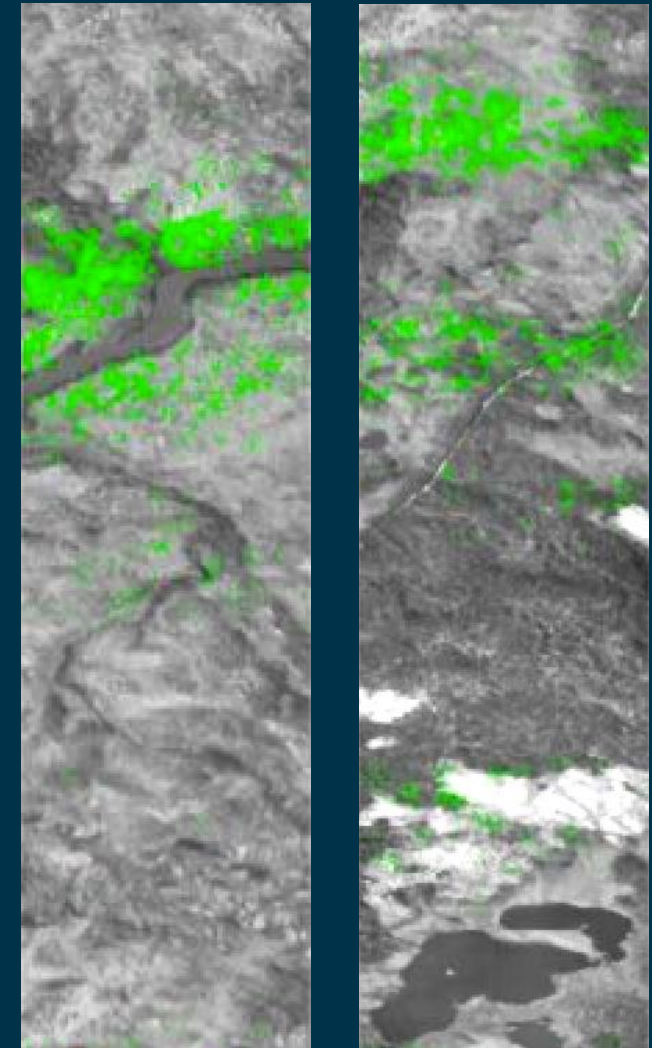
(color-coded) provided by:

Tiina.Markkanen@fmi.fi

Maarit.Raivonen@helsinki.fi

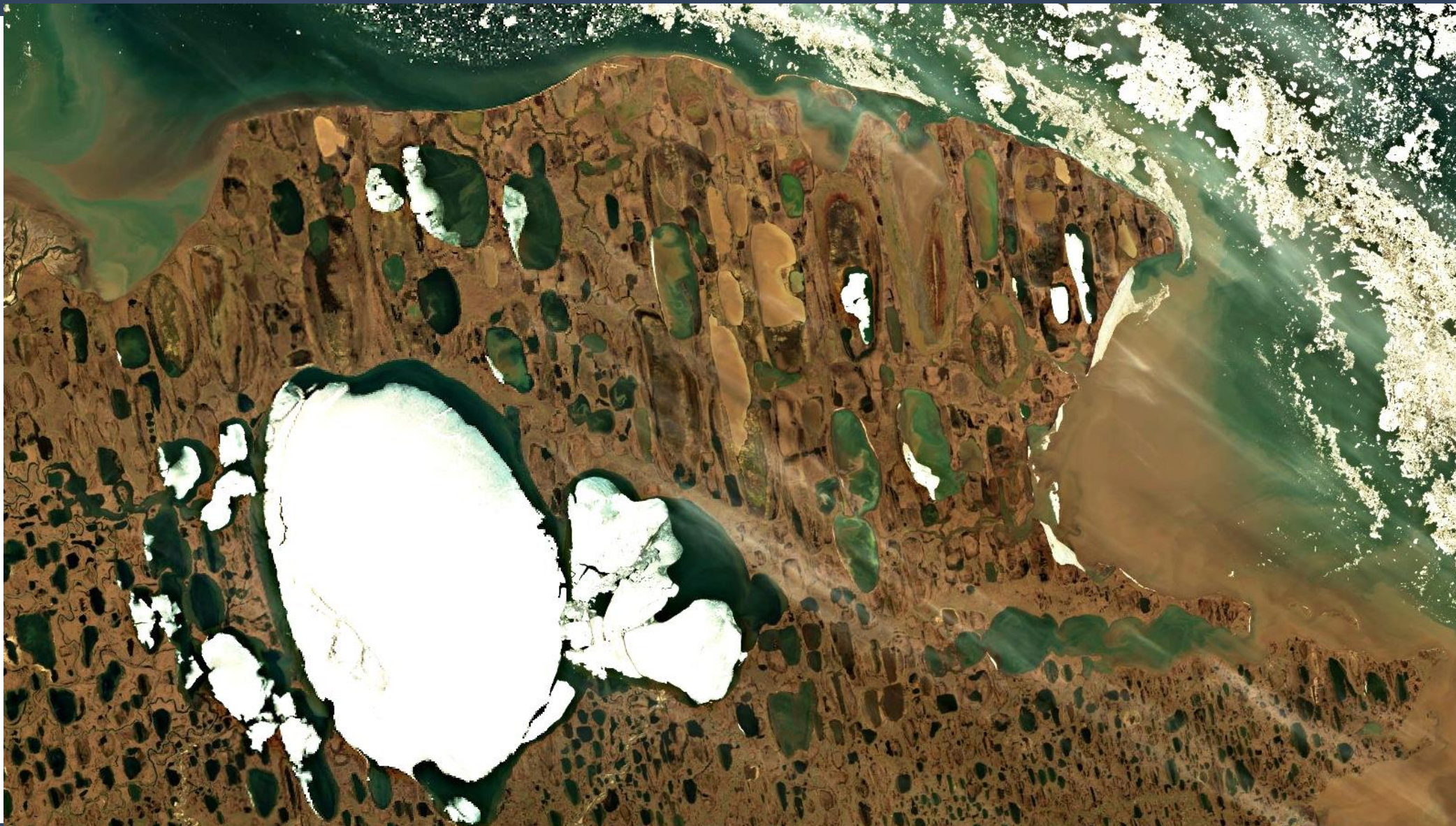
<https://essd.copernicus.org/articles/13/2307/2021/>

(in addition the forecasted TROPOMI Orbit superimposed in pink)



First Methane quicklooks from HyTES! Please contact simon.j.hook@jpl.nasa.gov

In-situ methane measurements boundary layer vs model – DLR Cessna 208



- ❖ Well-established mechanism for reporting anthropogenic emissions due to human-induced changes of land use.
- ❖ Comprises essentially two elements: **activity data** (how much of each defined cover type is converted to each other type in the period in question) and **emission factors** (the emissions generated per unit area of each element of the conversion matrix). CEOS can clearly **assist in the former, and possibly the latter through e.g. biomass estimates**. Several levels of approach.
- ❖ Note **AFOLU says nothing about the instantaneous fluxes** from any part of the terrestrial biosphere and is therefore in a separate class of measurement from that needed for carbon flux modeling and inversion of atmospheric GHG observations
- ❖ **These two aspects should not be confused**. They can only be reconciled by confronting the integration, over a fixed period, of the inferred fluxes from LU change with AFOLU computation of the delta between carbon stocks in the biosphere.

❖ **Recommendation 5:**

The AFOLU Roadmap Team should continue the work it has started for CEOS, reflecting the decisions taken at CEOS Plenary 2020. The AFOLU Roadmap Team and WGClimate GHG Task Team should work together to ensure consistency between data for emissions reported via AFOLU and for prior biogenic terrestrial emissions, and those due to changing land use, in implementing monitoring and verification systems. These need to be consistent on both temporal and spatial scales. The WGClimate GHG Task Team should ensure that their Roadmap is consistent with the outcomes of this discussion.

Status: very active cooperation between GHG and AFOLU teams in preparation for CoP27. Need for reconciling BU/TD approaches and observations needs through the AFOLU/GHG teams.

❖ **Recommendation 6:**

It is recommended that to help in ensuring the take-up of satellite-based methods for AFOLU (and indeed in the context of MVS) CEOS should work with a few selected demonstrator countries to assist them in their national reporting under AFOLU (the model of GFOI can be compared). USGS through its SilvaCarbon programme has volunteered to lead this work, together with relevant CEOS bodies (LSI-VC, AFOLU Roadmap Team, CEOS member contributions).

Status: Considerable progress has already been made in engaging with specific countries .

❖ Data and Standards:

- ✦ Consistency of products over time back to 1990 (at least)
- ✦ New Products (land management disturbance)
- ✦ Additional emphasis on Agriculture (incl. livestock) and OLU (GEOGLAM)
- ✦ Harmonisation e.g. biomass towards
- ✦ Improved Emission Factors

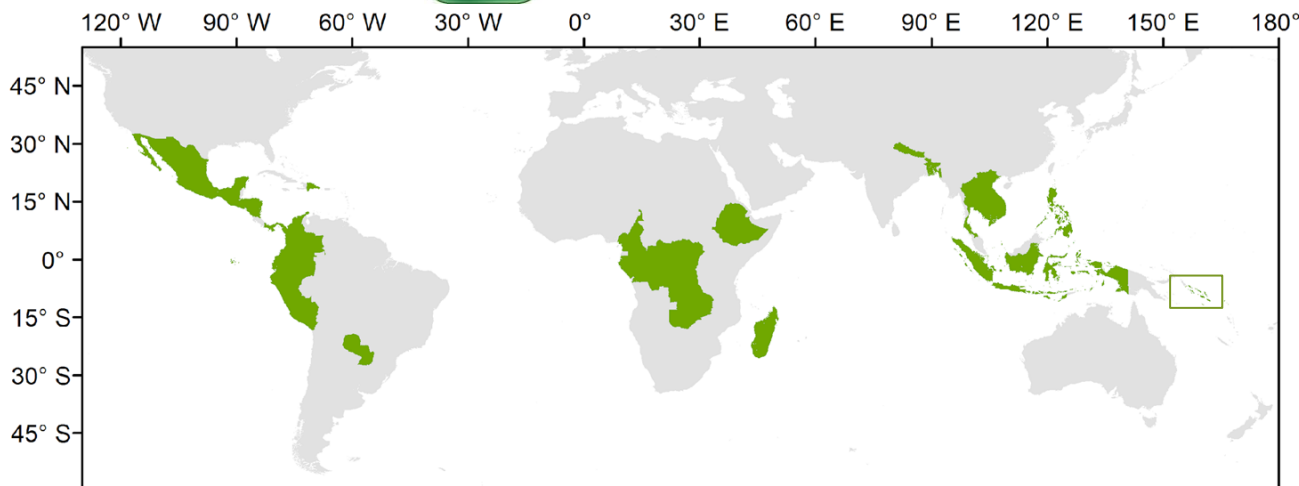
❖ Engaging Carbon Cycle Community

- ✦ (Internal) consistency of products (GHG & AFOLU) and within AFOLU
- ✦ Cooperation with DGVM community
- ✦ Lateral flow related observations
- ✦ Model developments e.g. CO₂ fertilization / photosynthesis
- ✦ IMBIE type experiments (Eastern Amazonia, West Africa, and Southeast Asia...)

National Inventory User Engagement



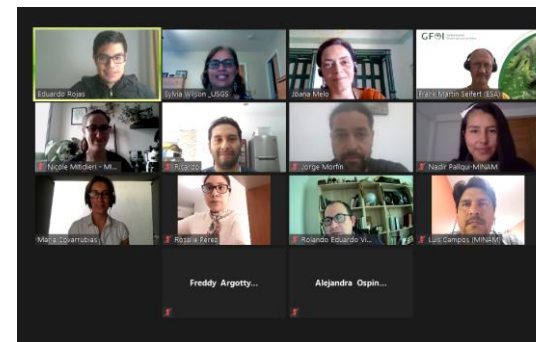
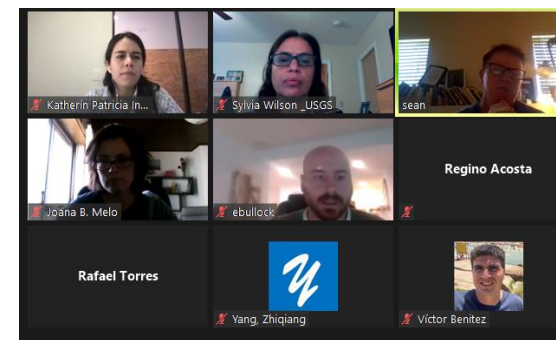
Preliminary engagement to introduce the CEOS AFOLU initiatives and products



Colombia
Costa Rica
Dominican Republic
Ecuador
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama
Paraguay
Peru

Congo
DRC
Cameroon
Ethiopia
Gabon
Madagascar
Zambia

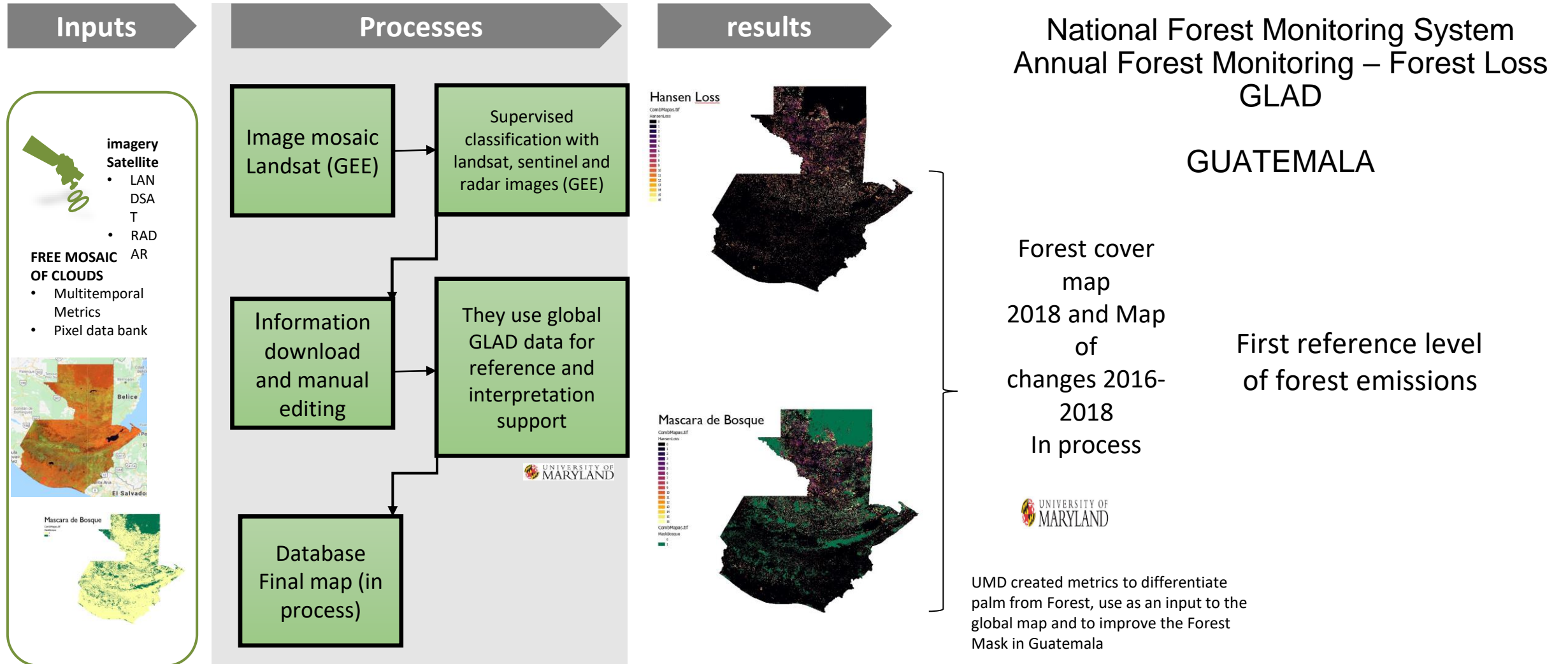
Bangladesh
Cambodia
Indonesia
Lao PDR
Nepal
Philippines
Solomon Islands
Thailand
Viet Nam



National Inventory User Engagement



Existing examples of data and products use in MRV



National Inventory User Engagement



Collaboratively develop demonstrations of Earth Observations uptake

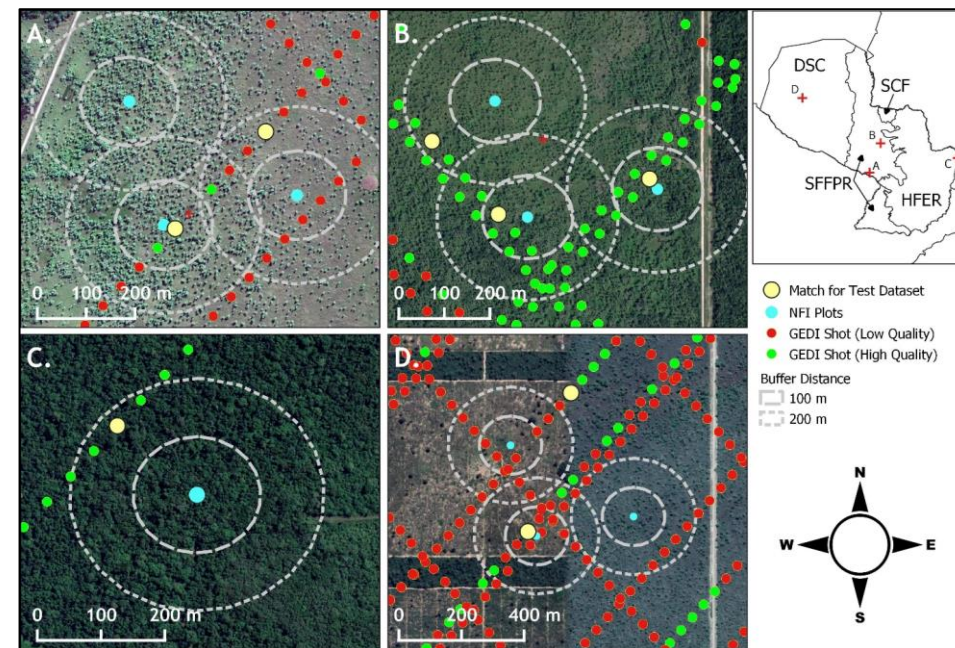
National technical teams + global monitoring experts (CEOS) + LULUCF experts in IPCC guidance

Practical implementation of the 2019 Refinement to the 2006 IPCC Guidelines

Using GEDI and Landsat to Evaluate and Improve Paraguay's National Forest Inventory for Estimating Forest Carbon Stocks



COP26 Forests and Carbon from Space Event, 6 Nov, Green Zone



- ❖ **Recommendation 7:** CEOS should work with the various partners set out above {Climate Services, WMO, GCOS, NMHS, GEO WG Climate et al.} to identify data requirements and actions for CEOS *in relation to adaptation*, including participation of relevant CEOS groups such as WG Climate and WG Disasters. Case studies might be of value to demonstrate competence and relevance. Partnership with specific countries in implementing their NAPs could be of value, as in the case of AFOLU above, both to demonstrate worked examples and to strengthen support for this approach at UNFCCC, including at CoPs.

Status: CEOS is actively engaged through various WGs with GEO and WMO and others in furthering adaptation mechanisms and use cases

- ❖ **Recommendation 8:** Agencies should maintain a watch over the implementation of projects funded through climate fund mechanisms to ensure that all appropriate assistance is given by agencies in their implementation and governance.

Status: SIT Chair will continue to maintain watching brief on funding mechanisms and relevant issues for CEOS and report back to SIT.

- ❖ **Recommendation 9:** *CEOS must continue all efforts to provide the necessary baseline climate data records which support the long term modelling of the Earth system, its response to changing GHG emissions and other drivers, and impacts of climate change.*

Status: CEOS ongoing baseline efforts are led by long-term WGClimate actions in support of IPCC WG I: it is recognised that these baseline climate data records also provide necessary ancillary information required for models in the MVS being developed